KFUPM - COMPUTER ENGINEERING DEPARTMENT

COE-540 – Computer Networks
Quiz 01

Student Name:
Student Number:

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a) Sending at the rate of b bits per second → we are sending one byte (8 bits) every T = 8 / b seconds.

➔ fundamental frequency f_0 = 1/T = b/8 Hz.

Telephone channel bandwidth, BW = 3 kHz = 3000 Hz.

The question is how many multiples of f0 we can fit in the telephone channel BW ➔ number of harmonics = $\left\lfloor \frac{3000}{b/8} \right\rfloor = \left\lfloor \frac{24000}{b} \right\rfloor$, where $\lfloor x \rfloor$ is the largest integer smaller or equal to x. Substitute for b the value of 9600 and you get $f_0 = 1200$ Hz and number of harmonic is 2.

b) Using Shannon capacity C = B log2(1 + SNR) = 3000 log2(1 + 10^(30/10)) = 29.9 kb/s

c) When noise is ignored → We can use Nyquist criterion → Every 1 Hz can do 2 symbols per second, or C = 2B log2(M) – where M is the alphabet size.

We can choose M arbitrarily large ➔ C = infinity.

d) To achieve C = 29.9 kb/s using a bandwidth of 3000 Hz

C = 2B log2(M) → M = roundup(2^ (M/2B)) = 32 symbols or signaling elements.